PTO: 2007-0700
Japanese Published Unexamined (Kokai) Patent Publication No. 54-130451; Publication Date: October 9, 1979; Application No. 53-038724; Application Date: March 31, 1978; Int. Cl.^{2}: B23K 31/00 C21D 9/50; Inventor(s): Mutsuo Nakanishi et al.; Applicant: Sumitomo Metal Industries, Ltd.; Japanese Title: Hagane no Yousetsutsugitebu no Zanryuuouryoku Keigenhouhou (Residual Stress Reducing Method for Welded Joint of Steel)

Specification

1. Title of Invention

Residual Stress Reducing Method for Welded Joint of Steel

2. Claim

A residual stress reducing method for a welded joint of steel, characterized in that at a welding for a steel joint, after at least the final layer of a deposited metal has been welded using an austenite metal whose initial martensitec transformation temperature (a Ms point) becomes room temperature or lower, it is cooled to a temperature that is lower than the initial martensitec transformation temperature to generate martensitec transformation to the deposited metal at the joint.

3. Detailed Description of the Invention

This invention pertains to a method for reducing tensile stress (residual welding stress) that remains on the welded joint.

The residual welding stress occurs due to contraction of a deposited metal at the welding area at a cooling process. Fig.1 illustrates a relation between the temperature of the welding area and the residual stress. When the joint is welded using a regular ferrite

metal (as indicated by a dashed line), the tensile stress due to contraction of a deposited metal is fully absorbed by plastic deformation of the deposited metal per se as the yield stress of the deposited metal is low when the temperature of the welding area is between the coagulation point and about 600°C. If the temperature of the welding area becomes lower than the coagulation point, it becomes difficult for the deposited metal to achieve plastic deformation. As a result, tensile stress due to later contraction is accumulated in the welding area as it is as residual stress.

Such residual welding stress is considered to be one of the causes for brittle fracture accidents and fatigue breaking accidents of welded structures. It is extremely critical to take measures for reducing the residual welding stress on production of welded structures. Residual stress is dispersed conventionally by applying a heating process to the welding joint (by a SR process). Such a heating process may cause brittleness of the joint. It is often difficult to repair existing structures by a welding means as they deform by a heating process even though particularly large residual stress occurs to the welding area.

In the light of the aforementioned disadvantages, the invention aims to offer a novel method for reducing residual stress at the welding joint without applying any heat treatment. The body of the invention is as a method for reducing residual stress at the welding area, such that after at least the final layer of a deposited metal has been welded using an austenite metal whose initial martensitec transformation temperature becomes room temperature or lower, it is cooled to a temperature that is lower than the initial martensitec transformation temperature to generate martensitec transformation to the deposited metal at the joint; that the contraction of the deposited metal is compensated by transformation expansion generated when austenite is transformed into martensite.

At the method of the invention, the reason that the Ms point of the austenite deposited metal is regulated at room temperature or lower is as follows. When austenite transforms into martensite (an Ar^N transformation) at the cooling process, it becomes extremely brittle. Due to the extreme brittleness, when the martensitec transformation occurs to the deposited metal at room temperature or higher, martensite continues to be contracted to generate large tensile stress (as indicated by a long and short dashed line of Fig.1). Because of this, as the austenite deposited metal at a Ms point at room temperature or lower is used, as indicated by a solid line of Fig.1, residual stress generated at the cooling process up to the room temperature becomes relatively small as a part of the contraction of the deposited metal is absorbed in large plastic deformation by austenite. Residual stress accumulated during the absorption forcibly cools the welding area to a temperature lower than the Ms point to generate martensite transformation. By these means, the deposited metal almost completely annihilates. In turn, it is also possible to add compression stress to the welding area at a process in that the temperature returns from the cooled temperature to room temperature. As to deposited metals suited for the working example of the invention, a 15Cr-8Ni alloy, an 18Cr-7Ni alloy and a 25Ni alloy are exemplified.

At the method of the invention, as shown in Fig.2 (I), all deposited metal layers at the welding area can be composed of an austenite structure (1). As shown in Fig.2 (II), a decorative application of an austenite metal is applied onto the top of a regular deposited metal to form an austenite structure (II) as the final layer of the deposited metal at an area where stress is particularly concentrated, more specifically, a bead stop end. As to the cooling process after the welding, as described above, the welding area can be cooled to

the temperature at the Ms point or lower. In order to stabilize and uniformize the martensitec transformation of the deposited metal, prevent the regeneration of nonuniform transformation after the welding process has been applied, and to avoid deformation and the like, the welding area is preferably cooled to -60°C or lower. As to a blocking agent in this case, liquid hydrogen is used.

The operation effect of the invention is indicated next, comparing with prior art method.

[Working Example]

A test is conducted using the following four types of welding rods using a steel plate at a 19 mm thickness (C: 0.13; Si: 0.35; Mn: 125; P: 0.015; S: 0.011) as a base material: low hydrogen type (a conventional type); a 15Cr-8Ni type; a 17Cr-7Ni type; a 25Ni (types of the invention). The compositions of the deposited metals, Ms points and welding conditions are indicated in Table 1. At the method of the invention, liquid hydrogen is further sprayed to the welding area to be cooled to -90°C so that martensite transformation is generated to the deposited metal. The presence or absence of transformation is determined by a ferrite indicator that uses a magnet. As shown in Fig.4, the residual stress at each welding area is measured by a distortion gage 2 adhered on the joined area between the base material and the stop end of the bead. The measuring results are indicated in Table 1. In Table 1, the measuring results when the final layer of the deposited metal alone is turned into an austenite structure.

Table 1.

	Compositions of		Welding	Welding residual stress (kg/cm^2)

	deposited metals (%)		conditions	All layer welding	Final layer welding
Comparative method	Low hydrogen type [Please refer to the original description]				
Method of the invention	15Cr-8Ni type 17Cr-7Ni type 2.5Ni type				

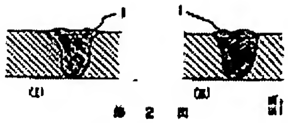
As is indicated in Table 1, according to the invention, the residual tensile stress of the welding area can be significantly reduced and converted into compression stress. Since the residual stress is reduced without relying on the hest treatment, an increased brittleness associated with the heat treatment is eliminated, thereby obtaining a joint with a sufficient quality.

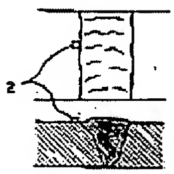
4. Brief Description of the Drawings

Fig.1 is a diagram illustrating the change in welding residual stress according to the difference in the compositions of deposited metals. Fig.2 (I) (II) are cross-sectional views illustrating the distribution of an austenite structure at a welding area by the method of the invention. Fig.3 is a cross-sectional view illustrating an open tip shape of a welding base material provided at a comparative test. Fig.4 illustrates the measuring location for stress at the comparative testing.

1...Austenite structure

2...Distortion gage





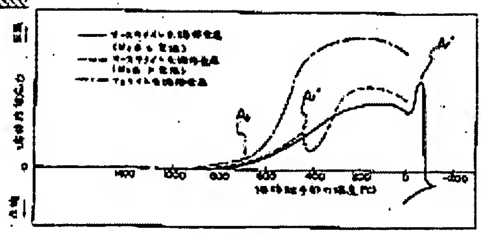


Fig.1:
Solid line: Austenite welding metal (Ms point ≤ current)
Dashed line: Austenite welding metal (Ms point > current)
Long and short dashed line: (Ferrite welding metal
Vertical line: Welding residual stress
Upper arrow: Tensile
Lower arrow: Compression
Horizontal line: Temperature of the welding joint area

U.S. Patent and Trademark Office
Translations Branch
11/17/06
Chisato Morohashi